Approach & Methodology

The goal of this assignment was **player re-identification and tracking** in sports video footage using a **single camera feed**.

My approach combined:

- **Object Detection**: Using a fine-tuned **YOLOv11** model (`best.pt`) to detect players, referees, and the ball.

- **Object Tracking**: Using the **DeepSORT** framework (Kalman Filter + IOU-based association) to maintain consistent player IDs across frames.

- **Integration**: A Python script (`detect_and_track.py`) handles:

  - Loading YOLO

  - Running detection on each video frame

  - Filtering for **only player class detections**

  - Passing those detections to the DeepSORT tracker

  - Drawing bounding boxes and unique IDs on the output video.

Techniques Tried & Outcomes

- ❖ **Class-specific filtering:** Ensured only the **player class** (class ID 2) is passed to the tracker, ignoring balls and referees.

- ❖ **DeepSORT-style trackin**
  - ➢ Re-implemented a **Kalman Filter** for constant velocity prediction of bounding boxes between frames.
  - ➢ Used an **IOU-based cost matrix** for data association to match new detections to existing tracks.
  - ➢ Applied a simple **linear assignment algorithm** to associate detections and tracks with minimal cost.

- ❖ **Edge case handling**
  - ➢ Added input validation to the Kalman filter to avoid invalid covariance updates and singular matrix errors.
  - ➢ Added safeguards for cost matrix calculations to prevent NaNs or infinite values during linear assignment.

❖ **Output visualization**
➢ Added bounding box drawing with unique track IDs for easy visual verification.

Challenges Encountered

● **Kalman filter errors:** Early versions produced singular matrices when detections were missing or zero-area boxes appeared. Improved numerical stability resolved this.

● **Incorrect class tracking:** Initial tests showed the ball being tracked as a player; filtering by class ID fixed this.

● **Bounding box format mismatches:** Ensured consistent bounding box shapes across the detection.

Remaining Work & Future Steps

The current implementation achieves **basic multi-player tracking** in a single video.
 If I had more time and compute, I would:

● **Add appearance embeddings:** for more robust identity tracking.

● **Improve re-identification:** Train a custom re-ID network on player jersey numbers or uniform color.

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